



Industrial Gasification: Meeting the Needs of an Emerging Market

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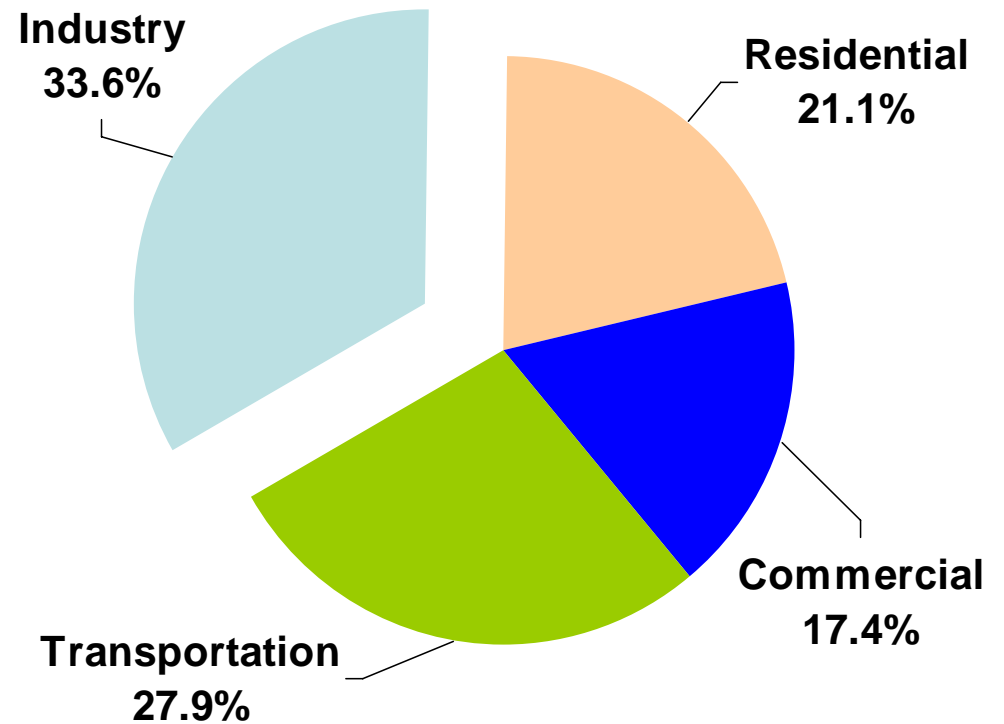
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Industry: Critical to National Energy Picture

- Uses more energy than any other single sector
- Accounts for more than 40% of U.S. **natural gas** demand
- Accounts for 28% of U.S. **electricity** demand
- Produces approximately 30% of U.S. **greenhouse gas** emissions
- Energy is key to **economic growth** in domestic manufacturing
- “Many companies have been unable to pass higher energy costs on to their customers, which has sharply reduced their profit margins”
National Energy Policy, pages 2-4

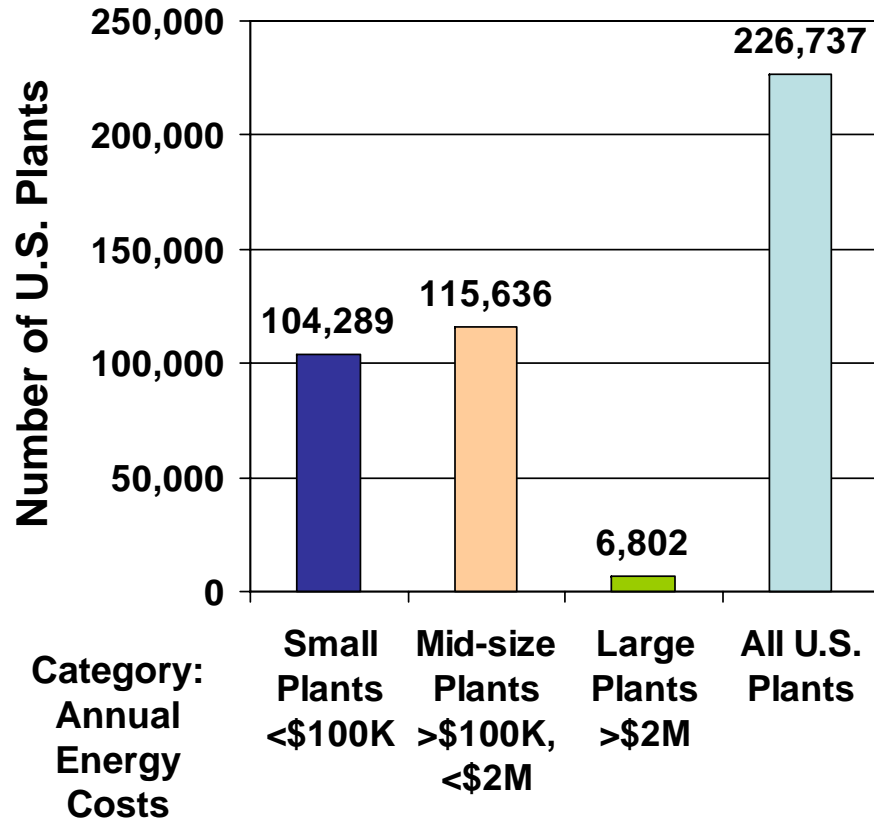
2004 Energy Use*



* Includes electricity losses

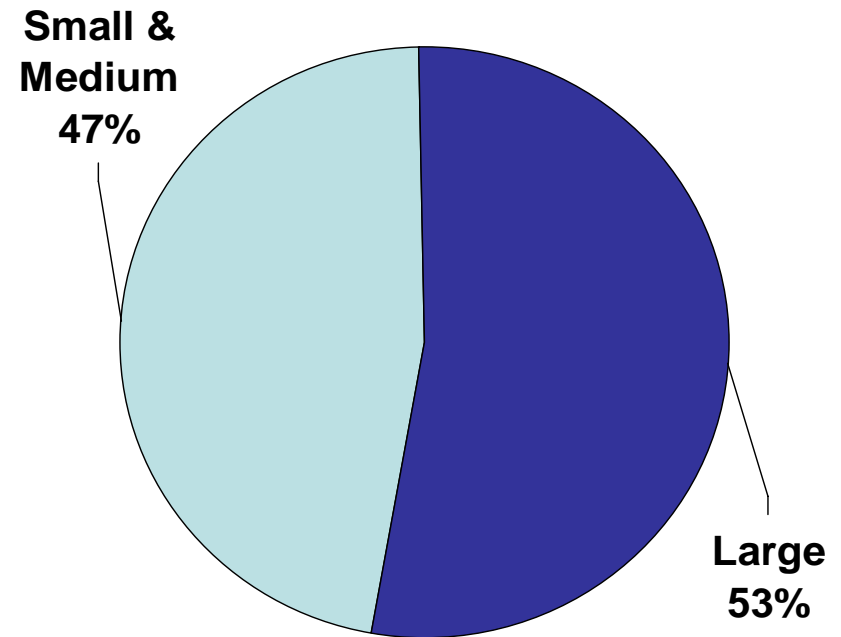
Source: DOE/EIA Monthly Energy Review 2004 (preliminary)

U.S. Manufacturing Plants by Size



Source: 1998 EIA MECS

Percent of Total Industrial Energy



While large plants use over half the energy in industry, they only represent 35 of total plants.



Key Observations

- **Industry needs alternatives to high priced, volatile, and potentially unsecured natural gas (NG) used for process heating and as a chemical feedstock**
- **Fuel flexibility is a critical development area, and gasification is an element of fuel flexibility**
- **Industry “experts” have identified gasification as a partial solution, yet industry has not embraced gasification for various reasons**
- **The technical readiness of compact gasifiers for industry is no longer a technical issue**

Gasification Technology Is Ready

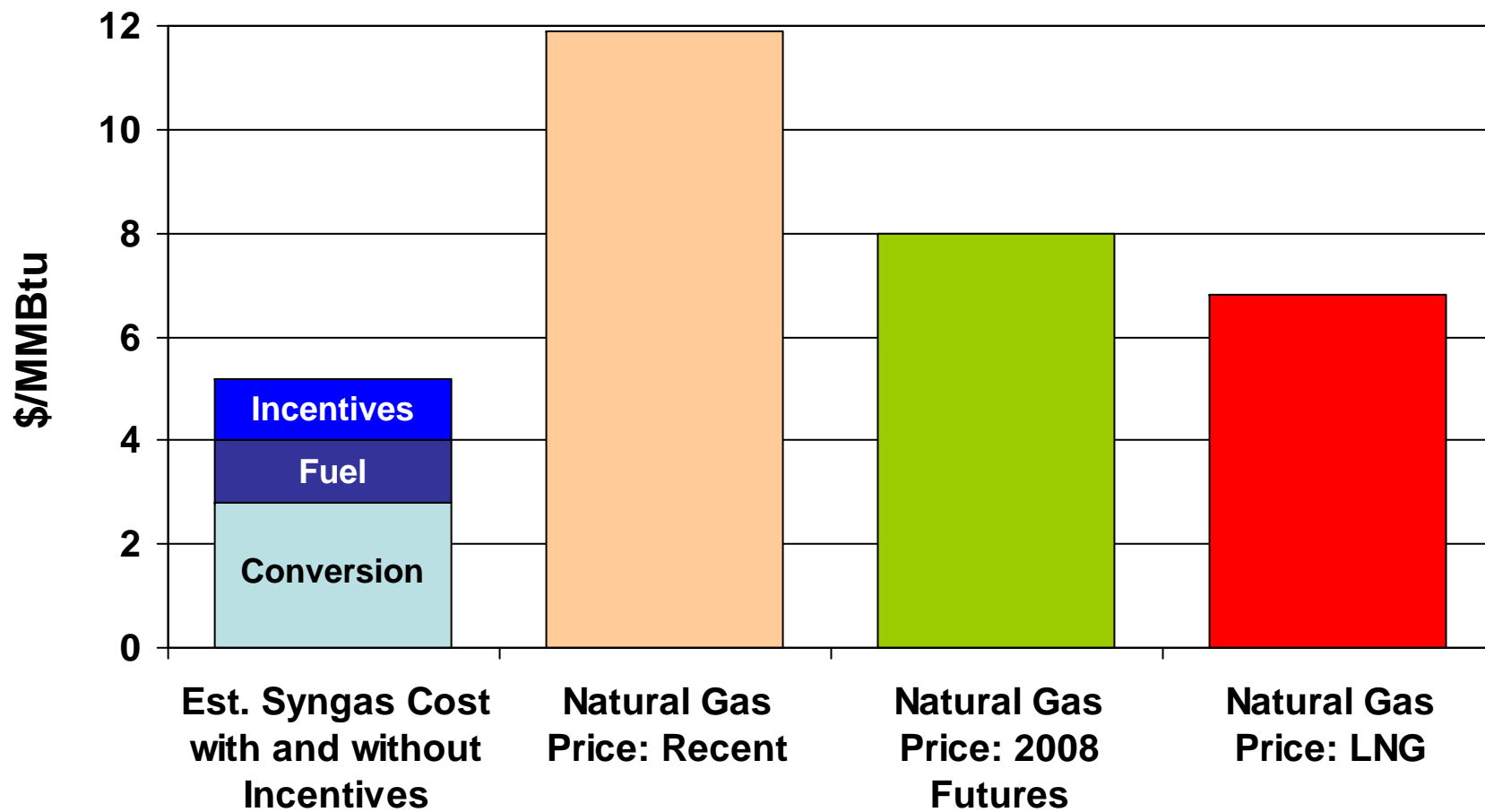
- **“There are 385 gasifiers in operation at 117 projects worldwide. These gasifiers are used to produce liquid fuels in South Africa, chemicals in the U.S. (Eastman), electricity in the U.S., methane in the U.S. (Great Plains), and ammonia fertilizer in China and India. There are several different commercial gasifier designs available, including systems from GE Energy, ConocoPhillips, Shell, Lurgi, Prenflo, and Noell. Each of these systems has been proven in commercial use around the world.”**

Source: Recent survey by the Gasification Technologies Council cited in The National Gasification Strategy (2005).

- **However, these technologies are extremely large and now need to be cost-efficiently scaled down to serve industrial applications.**

Economic Opportunity

Syngas is highly competitive at current and projected gas prices



Business Challenges to Increase Use of Gasification for Industrial Applications

- ***Natural gas price volatility:***
Although natural gas prices are presently high, investors require evidence of a sustained price signal above which their investment is profitable
- ***Project cost uncertainties:***
First-of-a-kind designs and applications can be risky; such risks must be weighed against the relatively known risks of relocating processes in lower cost areas
- ***Project timing risks:***
The construction period for new facilities may often exceed the period over which an investor can tolerate zero cash flow from the project
- ***Capital availability:***
Corporations have finite resources and often prefer to invest in improvements directly related to their core business, as opposed to backward integration through the value chain

Technological Challenges to Increase Use of Gasification for Industrial Applications

- ***Efficiencies and reliabilities:***

Industry needs very high availability factors; however, current practice of adding a spare gasifier increases overall cost. Increases in the output derived per dollar invested, as a result of improved system reliability and operating efficiency, will increase project viability

- ***Scalability issues:***

Currently available gasification technologies require significant economies of scale to be profitable; improving the economics of smaller systems will increase the market size for gasification technologies and the rate of substitution

- ***Process integration concerns:***

The chemical composition of syngas may differ from natural gas sufficiently to adversely impact some industrial processes and end products. Experience with gasification-based syngas can reduce such impact

Addressing Technical Obstacles for Large Systems Requires a Focused Effort

- Efficiency improvements in a variety of system components*
- Means to distribute syngas from central facility to remote users
- Improved process automation and control systems
- Understanding of syngas composition variability and associated impact on existing processes/equipment*
- Gas composition enhancements and contaminant removal*
- Availability of improvements and operational optimization*
- Carbon sequestration methods
- Fuel flexibility through increased co-firing or fuel switching*
- Improvements on reliability, especially with respect to number of gasifiers and nature of application
- Air system and membrane separation improvements
- Solid material handling issues

***Technical obstacles shared by both large and small gasification systems.**

Addressing Technical Obstacles for Small Systems Requires a Focused Effort

- Efficiency improvements*
- Understanding of syngas composition variability and associated impact on existing processes/equipment*
- Gas composition enhancements and contaminant removal*
- Availability improvements and operational optimization*
- Fuel flexibility through increased co-firing or fuel switching*
- Identification of components and subsystems that inhibit cost-effective scaling
- Development of modular designs to reduce design challenges and costs
- Multi-fuel compatible gasifier
- Novel designs and process flow improvements to enable use of lower heating value fuels

***Technical obstacles shared by both large and small gasification systems.**

Industrial Gasification Next Steps

- **Actions to be taken:**
 - **Develop, test, and demonstrate the technical feasibility of small- and medium-sized gasifiers**
 - **Extend the range of cost-efficient gasifiers to smaller units**
 - **Extend the range of gasifiers to additional industries**
 - **Identify the unique requirements for each identified industry:**
 - **Process integration**
 - **Preferred size range(s)**
 - **Fuel feedstock**
 - **Identify regions of U.S. where large gasifiers can serve multiple industrial plants**
 - **Develop and engage with stakeholders, developers, and users**

Fuel and Feedstock Flexibility

■ Goal:

- Achieve substitution of traditional fuels for common industrial processes
- Increase the options available to industry by developing fuel flexibility technologies

■ Strategy:

- Increase fuel switching and use of alternative fuels and feedstocks
- Better understand opportunities and barriers for fuel sources that can replace natural gas and oil dependency
- Catalyze available knowledge and research in support of Industrial Gasification

Alleviate natural gas reliance in a relatively short timeframe, focus both on supply and demand

1. Supply: Pursue fuel substitution, accelerate supply choices “at the pump”
2. Demand: Pursue switching at point of consumption, fuel-flexible machines and processes

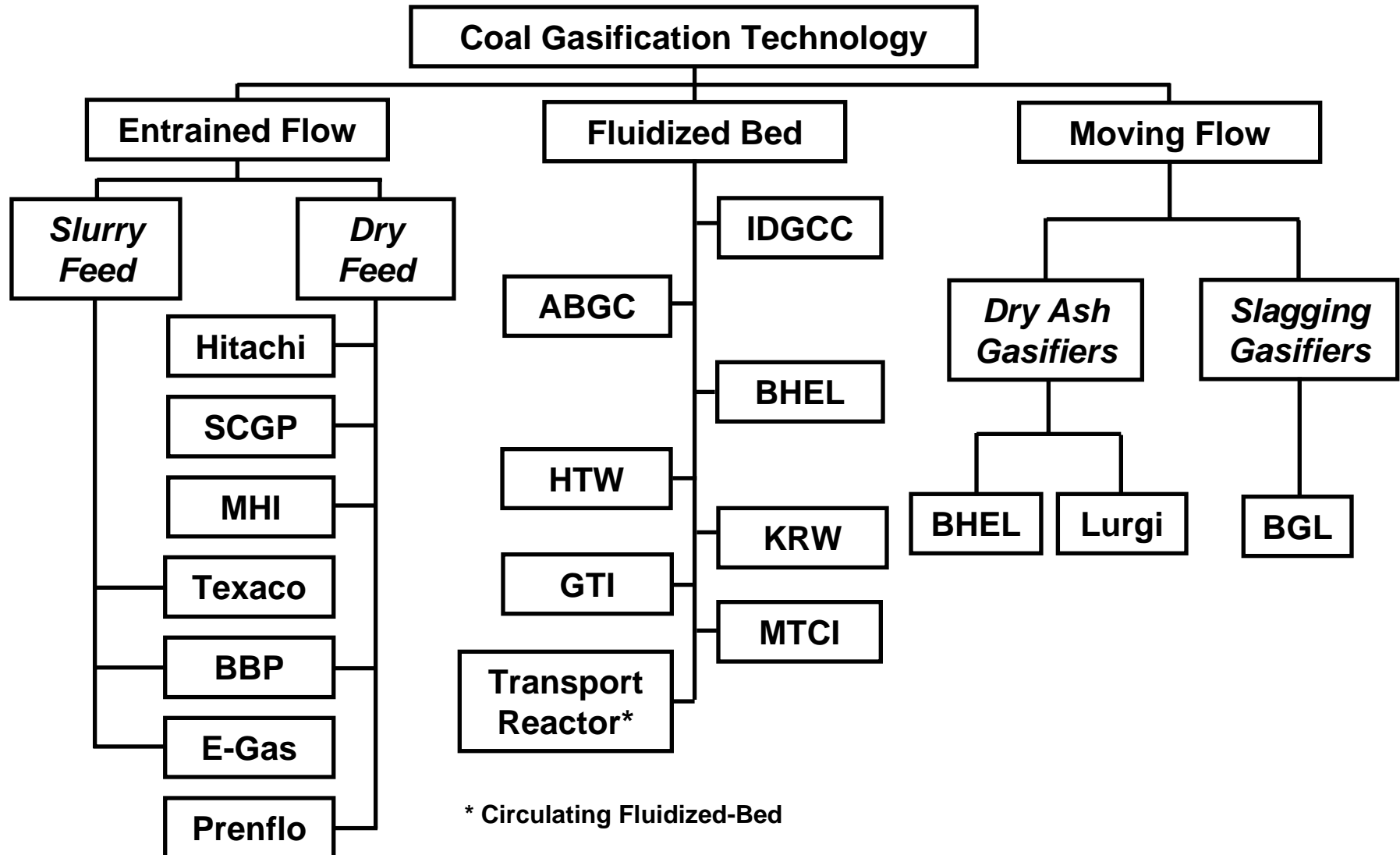
Potential Natural Gas Displacement (TBtu)

Application	Near term (<5 yrs)	Long term (>5 yrs)	TOTAL
Feedstock	--	700	700
Process	300	1,380	1,680
Boiler	950	800	1,750
TOTAL	1,250	2,880	4,130

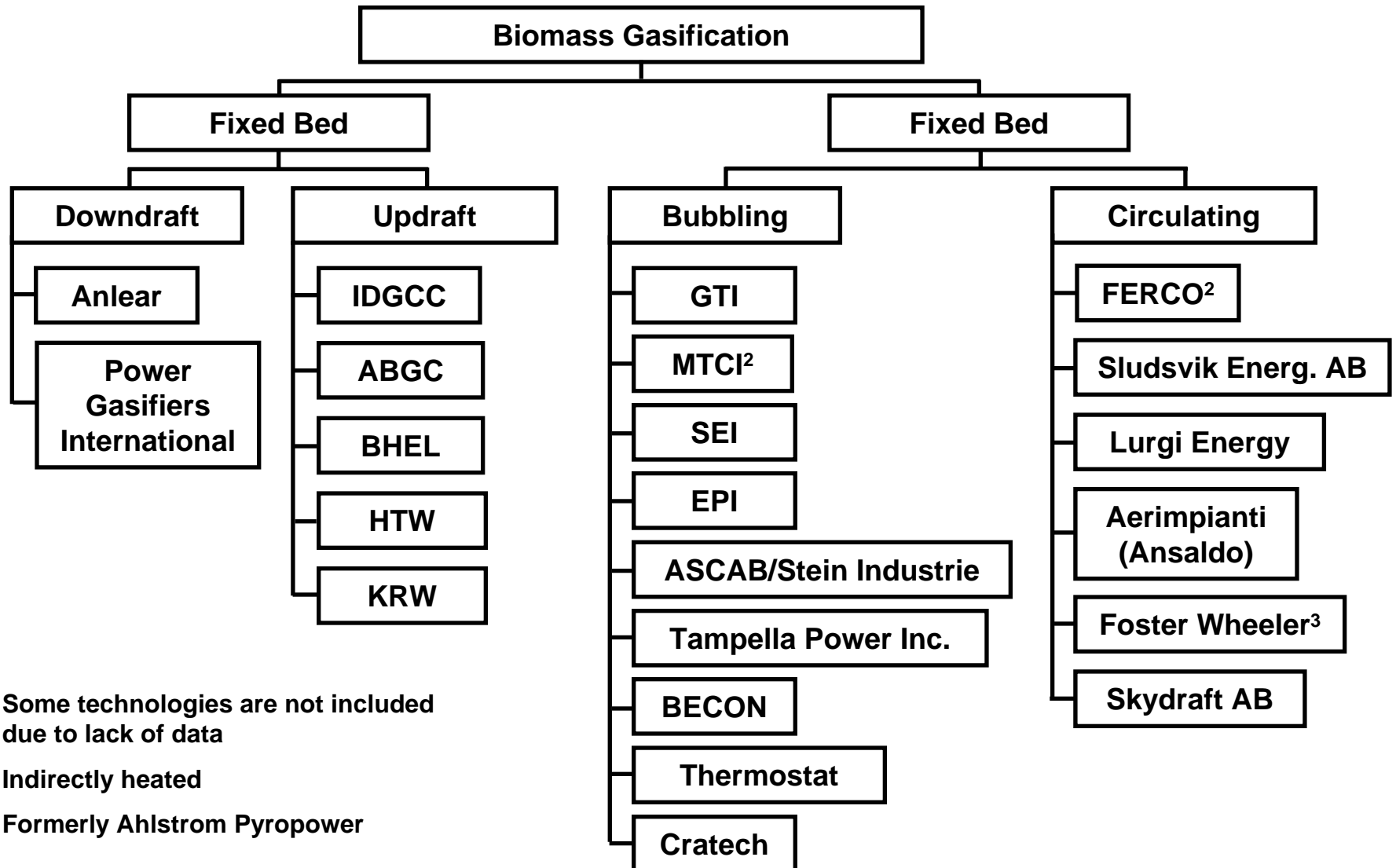


Supplemental Slides

Coal Gasification Technologies and Classifications



Biomass Gasification Technologies and Classifications¹



¹ Some technologies are not included due to lack of data

² Indirectly heated

³ Formerly Ahlstrom Pyropower